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(54) Scatter radiation fluoroscopy apparatus

(57) The invention relates to an apparatus for determining the internal structure of a body, comprising a radiation source 1 for emitting a primary radiation beam 4 which penetrates the body 6 and which has a substantially point cross-section at at

least one location 10 along its path, and a detector/collimator device 9 which detects only radiation which originates from the location of a given point cross-section 10 and which is scattered within a given solid angle 11. The detector device 9 is constructed and arranged so that it provides a discriminative measurement of scatter radiation extending in different directions within the solid angle 11, enabling a shadowgraph image of body structures 7 lying between the virtual point source of radiation, formed by the irradiated region 10, and the detector 8, to be displayed on a monitor 13. Also disclosed are a laminar source with collimator to produce a focussed beam, and an annular collimated laminar focussing source with concentric detector device to detect back-scattered radiation from the point of focus.

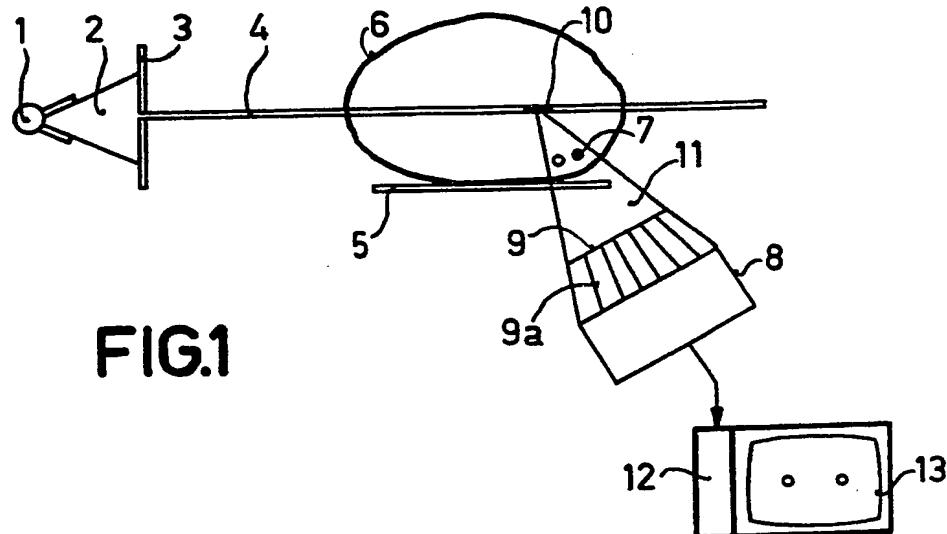


FIG.1

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SPECIFICATION

Scatter radiation fluoroscopy apparatus

- 5 The invention relates to an apparatus for determining the internal structure of a body, comprising at least one radiation source for emitting a primary radiation beam which penetrates the body and which has a substantially point cross-section at at least one location along its path, and at least one detector/collimator device for selectively detecting that radiation which originates from the location of the or a predetermined said point cross-section and which is scattered through a given solid angle in a direction which is different from the primary beam direction.

An apparatus of this kind is known from German Offenlegungsschrift 24 61 877. A collimator therein forms a narrow primary beam which passes through the body, whilst a detector which is arranged behind the collimator measures the intensity of the total amount of scatter radiation passing through the collimator in order to determine a separate value which is associated with a relevant point of the body, for example, for the body density at that point. Thus, the detector supplies a detector output signal which relates to only one corresponding body point at a time.

For imaging a larger region of the body, several adjacent body points are considered, and for these points corresponding density values are determined on the basis of the scatter radiation measured on each occasion. To achieve this, the detector/collimator device and the primary beam are displaced relative to the body. Thus, only those body points are considered which are irradiated by the primary beam. Therefore, the apparatus is not suitable for determining the internal structure of body regions which are not irradiated by the primary beam.

It is an object of the invention to provide improved fluoroscopy apparatus which enables, while utilizing scatter radiation, a determination to be made of the internal structure of body regions which are situated outside the path of the primary beam.

According to the invention there is provided an apparatus for determining the internal structure of a body, comprising at least one radiation source for emitting a primary radiation beam which penetrates the body and which has a substantially point cross-section at at least one location along its path, and at least one detector/collimator device for selectively detecting that radiation which originates from the location of the or a predetermined said cross-section and which is scattered through a given solid angle in a direction which is different from the primary beam direction, characterized in that the detector device is constructed and arranged to provide a discriminative detection and measurement of scatter radiation extending in different directions within said solid angle, the arrangement being such that a shadowgraph image of internal structures of the body lying between said location and said detector/collimator device can be derived from the output of said detector device.

To achieve this, the detector device is provided

with a sufficient degree of local resolution and with a collimator device so that from a point region, which may be considered as a virtual radiation source in this case the attenuation of the body region situated

- 70 between said point region and the detector collimator device, can be measured and a shadow image can thereby be formed of that body region. The said point region may be moved to the vicinity of a part of the body to be examined by displacement of the radiation source and the collimator/detector device, so that each time it is only necessary to irradiate a comparatively small part of the body. This is advantageous because this makes it possible in many cases for only those parts of the 80 body which are really important for an examination to be disposed in the path of scatter radiation from the irradiated point region, so that a fluoroscopic image can be obtained from the detector device which is not disturbed by adjacent structural features of the body.

The device is also suitable for testing materials, for example for defects such as air inclusions in, for example, cast aluminium objects. To achieve this, the said point region (herein also referred to as the 90 virtual radiation source) is moved, for example, into the vicinity of regions to be subjected to high mechanical loads, said regions being irradiated by the scatter radiation originating from the said point region. The presence of air inclusions affecting the 95 strength can then be readily observed in the fluoroscopic image.

Embodiments in accordance with the invention will now be described by way of example, with reference to the accompanying drawing, in which:

- 100 Figure 1 shows fluoroscopy apparatus utilizing scatter radiation produced by a narrow pencil beam of primary X-radiation.

Figure 2 shows a fluoroscopy apparatus utilizing scatter radiation produced by a focused beam of 105 gamma radiation, and

Figure 3 shows a fluoroscopy apparatus utilizing back-scattered radiation produced by a combined gamma radiation source and a detector device.

The apparatus shown in Figure 1 comprises an 110 X-ray source 1 whose radiation 2 is limited by means of a diaphragm 3 in order to form a primary X-ray beam 4 having a small cross-section (i.e. a pencil beam) which is directed through a body 6, for example, an object to be examined, which is situated on a

115 table 5. For imaging the body structures 7 to be examined or for determining whether certain structures are present within a given body region, for example, air inclusions in a cast object, the body 6 and the X-ray source 1 are displaced relative to each 120 other so that the primary beam 4 extends in the vicinity of the body structures 7 to be examined.

Adjacent the primary beam 4 there is located a detector/collimator device 8, 9 which is arranged to detect substantially only that radiation which originates from a point region of the body 10 situated in the path of the primary beam 4 and which has been scattered within a region represented by a solid angle 11 lying outside the primary beam. To achieve this, the detector device is provided with sufficient 130 local resolution so that thereby scatter radiation

the output of said detector device.

2. An apparatus as claimed in Claim 1, characterized in that the radiation source is an X-ray source with a collimator device which limits the radiation in order to form a narrow pencil-beam, the detector/collimator device being arranged to define a focal point at the origin of said solid angle situated on the path of the primary radiation beam.

3. An apparatus as claimed in Claim 1, characterized in that the radiation source is a laminar radioactive radiation source whose radiation which emerges from the surface, is directed towards a point focus by means of a collimator.

4. An apparatus as claimed in Claim 3, characterized in that the laminar active radiation source includes a central aperture for accommodating the detector device.

5. An apparatus for determining the internal structure of a body, substantially as herein described with reference to any one of Figures 1, 2 and 3 of the accompanying drawing.

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